The Influence of Surface Termination on the Electrochemical Properties of Boron Doped Semiconducting Diamond Electrodes

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Recently a number of papers have been published on the electrochemical properties of boron doped diamond films. In cyclic voltammetric studies performed using a range of electron couples oxidation and reduction peaks characteristic of redox reactions at metallic surfaces are observed. This despite the fact that diamond is a wide band-gap semiconductor.

This paper is concerned with studies of the electrochemical and photoelectrochemical kinetics at diamond electrodes and the mechanism of charge transfer. The experiments were performed on polycrystalline, boron doped diamond electrodes prepared by hot filament CVD; the deposition technique will be detailed and a novel method of forming Ohmic contacts to the material described. The results of detailed investigations of charge transfer in both aqueous and non-aqueous electrolytes will then be described. Cyclic voltammetric, impedance and intensity modulated photocurrent spectroscopy (IMPS) studies will be discussed. It will be demonstrated that at low boron doping levels a diamond electrode shows properties characteristic of a semiconducting material when the surface is oxygen terminated and a metal when hydrogen terminated.

The dependence of the charge transfer kinetics on surface termination will be discussed in terms of the change in the energy of band edges. In addition it will be shown that the impedance and intensity modulated photocurrent spectroscopy results for electrodes showing metallic behaviour are indicative of charge transfer via surface states.